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PROCEEDINGS OF THE WESTERN FOUNDRYMEN'S ASSOCIATION.

The regular monthly meeting of the Western Foundrymen's Association was held Wednesday evening, July 15, at the Great Northern Hotel, Chicago. The president occupied the chair.

J. B. Clements, of St. Louis, Mo., applied for associate membership in the association and on motion was elected.

The secretary announced that at the last meeting of the board of directors it was decided, on a motion duly passed, that no regular meeting of the association be held in August. He also stated that the next meeting would be held in Cleveland in September and that notices will be sent to the members as soon as they are ready.

Maj. Malcolm McDowell then read the paper of the evening, of which he is the author, entitled:

"PRACTICAL VALUE OF THE VARIOUS METALLOIDS IN CAST IRON."

The iron master of to-day, manipulating the modern blast furnace and improved paraphernalia, backed up by the scientific knowledge of his chemist, sees in the immense piles of ores

that lie in his yard great possibilities. The chemist begins the development of the ore. When the constituents and value of each kind of ore have been determined, the furnaceman uses the information in making up the different charges to produce a certain specified grade of metal. An error on the part of the chemist or a mistake made by the furnaceman in combining the ores and their fluxes or a failure to supply enough fuel or admit the air at a proper temperature would cause a failure in producing the grade of metal specified. While a scientific knowledge is essential, a practical application of the same is necessary, which is true not only for the blast furnace, but also in remelting the product in the cupola.

A large number of blast furnaces are run especially to turn out metal for steel-makers, according to specifications laid down by the steel-maker's chemist, who knows what grade of metal is necessary for his purpose. A few thousandths of one per cent more or less of certain metalloids will condemn the metal for making steel, but a percentage of phosphorus that would injure it for steel would not be objectionable in gray iron castings. So the grade of metal with this objectionable feature is called "off" or No. 2 Bessemer, and the foundrymen buy it for special castings. There are a few blast furnaces well located with reference to ores and fuel whose managers have taken the trouble to carefully and scientifically investigate the requirements of certain consumers and are meeting successfully their demands, sending out with each car of pig iron an analysis of the metal.

This method is proving satisfactory to both parties, for the foundryman, knowing what he gets, uses it intelligently and he can well afford to pay a premium for such metal. This will compensate the furnaceman for the extra cost of analyzing each carload shipped, especially as it relieves him of further responsibility. Northern blast furnaces running especially on foundry pig buy their ores where they can get them the cheapest, but they are termed "Lake Superior ores" and for this reason much is claimed for the metal they make, but only to a limited extent are these claims justified.

Southern blast furnaces that are favorably located with reference to fuel and ores are limited to local supplies and for this reason whatever grades of metal they make show more uniformity than in northern furnaces.

Each section grades its output by fracture, and numbers it from one to six, or from one to three, grading the remainder into forge, mottled or white.

The corresponding numbers of pigs from the northern and southern sections do not at all agree as to fracture, neither is there a reliable similarity in the corresponding numbers of furnaces in either section.

It is possible for a furnace that uniformly runs on the same ores and fuel, to establish grades and numbers by making first a standard and establishing it by repeated chemical analyses. The granular formation is subject to changes caused by the different temperatures at which the metal is cast, but these variations, which are the exceptions, can be noted, and runs of this sort kept out of the general output.

There is either ignorance, indifference or carelessness in grading pig iron and shipping the same on orders based on claims made by sales agents as to the analysis of the metal made.

In addition to the different numbers and grades, there has been added another variation which is designated by letters added to numbers, as "No. 2P" or "No. 2X," the full significance of which is known by the "Sales Agent" only. One of the most unsatisfactory things connected with buying metal by analysis is the card issued giving the analysis of certain brands by numbers, which usually does not correspond in the least with the iron delivered.

The great tonnage of pig iron is handled in the market by "Agencies." Some of these are directly connected with, or owners of blast furnaces and it is their business to sell the output. In many cases they make the price, but more frequently it is made by the management of the furnaces which is often influenced by its necessities as well as by the fair legitimate competition of its neighbors.

In the offices of the different agencies are young men who are the "Sales Agents" on the road representing the different furnaces. They are men with an honest, intelligent appearance and have an easy and agreeable address, with a fund of general information on all subjects, including statistics of iron made and sold in the world, especially in the United States, and more particularly by their firm. They have no scientific or practical knowledge of the making or using of iron. They don't need it. The foundryman has that, and they have the iron to sell, which has a reputation regarding which they are thoroughly posted. Among the many engaged as salesmen are some old veterans that have from experience formulated a "special mix" which usually consists of a variety of brands that they have for sale, in the make up of which is always a generous amount of "softener." This neutralizes any of the inequalities of the various "off" or unknown brands that are in the "mix." If this does not prove satisfactory to the foundryman, the sales agent reduces the amount of salable pig and adds instead more "softener." A salable pig will sell itself. It is the off or unknown brands which tax the salesmanship of the veteran, but it is this man the foundryman is always glad to see. The latter, knowing little of the value or influence of the different metalloids in the pig, or what to specify for his work, likes to divide the responsibility of his guesses with the sales agent, and the more he has guessing the larger number there are between whom to divide the responsibility of failure.

Both men see the practical value of a "neutral pig" or "softener," but while it gives a metal that can easily be machined, it often becomes spongy and weak just where it should not be, and thus there are constant failures in trying to produce a sound, solid, homogeneous casting that can be easily machined and has a fair measure of strength. The metal fails for the want of some other ingredient to counteract the effect produced by too much "softener."

A "softener" is not a "cure all" for all ills that metal is heir to.

The furnaceman and the foundryman are alike interested in knowing the value of each constituent element composing the

pig that is made by one and used by the other, not so much a scientific expression of their value, but a practical demonstration that will enable the one to formulate a specification of his wants that the other may meet the requirements with as much ease and precision as he does the wants of the chemist of the steel-maker.

As a general thing, the foundryman does not know the chemical constituents of a metal that will make a casting for a special purpose. He buys a metal from the furnaceman that the one thinks and the other hopes will make what they want, neither are certain—both are guessing—each holding the other responsible if it fails, both claiming the honor if it succeeds.

There is quite as much anxiety among furnacemen as among foundrymen to know whether there is going to be any "kick coming" when castings are made of a lot of pig iron guaranteed to do a certain work. Out of all this anxiety from "guessing" is evolving a new condition. Here and there foundrymen are adding laboratories to their equipment and the chemists are learning the value of certain metalloids in making special castings. The furnaceman is expressing a willingness to meet the requirements of the foundryman when he knows what it is he wants.

Furnacemen will learn for what kind of business their natural output is best adapted, and will turn their attention to some special grade and so perfect it, thus their natural advantages will give them the preference and quality will be quite as much considered as quantity.

Assuming the furnaceman is ready to fill specifications for grades of pig iron that will meet the requirements of the foundryman for his special work, it is then of great importance that the foundryman should know the value of the metalloids that combine with iron, and what should be their proportions to produce a certain grade or kind of casting.

There is, more or less, information scientifically expressed of the nature and relations existing between iron and carbon and the various influences exerted on them by the four different metalloids—silicon, phosphorus, manganese and sulphur. This in-

formation is not put in such a practical form as to designate the value of these elements in making up a specification for certain grades of metal.

We know, in a general way, that silicon in certain proportions does hold carbon in combination and in other proportions uncombines, and eliminates it—that it gives fluidity to molten metal—to a limited extent prevents blow-holes, but under other circumstances promotes segregation and sponginess. It reduces a tendency to shrink or chill, and alone does not make a strong casting, but is one of the most important metalloids that is combined with iron and carbon.

Manganese is equally as important as silicon, though almost directly opposite to it. It intensifies the affinity iron has for carbon, and when melted in its presence picks it up and combines it with the iron. It increases a tendency to shrinkage and chill, closes up the grain and makes it a stronger metal, frees it from blow and pin holes, prevents segregation and sponginess, but makes the metal hard and cold—short or brittle.

These two metalloids influence the relation between iron and carbon in the opposite direction, and neither by themselves make a desirable casting, but, combined in their proper proportions, they will give the best metal for a majority of work. Sulphur has little in it to recommend it to the favorable consideration of the foundryman. By some it is claimed as a desirable ingredient in making a chill. It merely makes iron white, and does not improve the chill, only increases its weakness. It is estimated that one atom of sulphur neutralizes ten of silicon, and when manganese is low the metal is divided into gray and white iron, assuming some very queer forms of distinct separation. When the manganese is sufficiently high these distinct lines of separation are broken up and the fracture shows a mottled bright gray or white, and the metal is hard, brittle and weak.

A few one thousandths of one per cent of phosphorus will render metal unsuitable for steel making, but will not be objectionable in castings; on the contrary, is desirable for most work where fullness and fineness of casting is required, and as

its tendency is to reduce shrinkage, it would gain strength by an increase of heat, a very desirable characteristic for many purposes.

In Howe's Metallurgy of Steel will be found the latest compiled information on the relation of these metalloids when in combination with iron, but there is nothing in that valuable work that gives the foundryman the value of these metalloids so that he may make up a specification for the furnaceman.

The majority of the foundry pig iron made is used in foundries making specialties where the same mold is duplicated, requiring the same metal, day after day and year after year. The conditions are uniform, and a metal to meet them is no more difficult to obtain than one to meet those requirements exacted by the steel-maker.

The difference between the foundryman and the steel-maker lies in that the latter knows the combinations and limitations of the different metalloids he wants, and the former does not, but when he does he will find plenty of furnaces well located for making his required grade of metal.

It is true, a blast furnace making foundry pig does not in each cast make one grade of metal only, but frequently makes all the numbers from one to six. Neither does the blast furnace running on metal for steel-makers, but the metal that would not meet the specifications would be the exception, and in each case this "off" grade metal from both kinds of furnaces would find sale in the large foundries where no special result is looked for, or in the job foundries, whose chief reliance is in the cast scrap of the country to be carried by pig or a softener.

There are various grades of scrap cast iron which have been melted and remelted until they are depleted of all the desirable metalloids and have picked up all the undesirable ones. Much of this is tolerated because it is cheaper than pig iron. Still the iron in the scrap is equally as good as the iron in the pig metal, and all it requires is to be revived, and any kind of casting can be made out of scrap that it is possible to produce from the best grades of pig iron, providing the foundryman knows the practical value of the different metalloids.

Nearly every foundryman has at times made an exceptional metal, but how he did it he does not know, nor has he ever since been able to reproduce it. Others have by experimenting with different brands of pig iron, produced an exceptional metal, and as long as they were sure of the same pig they duplicated it. But what special metalloids acted in combination with the iron they were unable to tell, and are no better off than the Ordnance Department of the United States Army is to-day as to what metalloid there is in "gun metal" that makes it what it is.

Back in the fifties the United States government made an appropriation for the Ordnance Department to experiment with reference to making a metal for cannon. Capt. Rodman was detailed to do this, and in July, 1856, he made the first heat. Preliminary heats were made to find the best pig metal to use in their mixture. They tried most all of the brands of charcoal pig then made, and selected a combination of "Greenwood" and "Salisbury" which were charged in the hot-air furnace, melted and cast into a pig and this pig was again melted and cast into the gun. In their first heat the metal remained in the furnace over five hours, becoming, as Capt. Rodman says, decarbonized, and the test bar showed a tensile strength of from 38,000 lbs. to 40,000 lbs., but was cold-short and brittle and was condemned. Subsequent heats brought the tensile strength below 36,000 lbs. and 33,000 lbs., which proved satisfactory, as the metal showed more elasticity.

The pig used was cold blast charcoal, the chemical analysis of which was not given, nor was there analysis of the resultant heats, but there was a marked difference shown by the physical tests.

Capt. Rodman claimed the "cold-short" heat of high tensile strength was decarbonized, but what the carbon or any of the other constituents were in the metal is not recorded, nor is there any record of a chemical analysis of the metal at any of the stages of these experiments. What it was or what it lacked chemically that made one specimen test stronger than another, but cold-short is not known.

If the United States Ordnance Department knows no more now than they did when "Rodman" formulated the specification for castings calling for "gun-metal," defined as charcoal pig metal melted in a hot-air furnace, they should be as interested in knowing the practical value of the metalloids that combine with iron in making special castings as the furnace or foundryman.

Failing to find records that give what is needed, and knowing from my own experience the great value of a knowledge of the relations which exist between different metalloids and iron in making castings, I think it would be advisable to make a series of experiments to determine these relations and their relative values.

I would use a cupola that would melt 1,000 lbs. an hour, taking 250 lbs. on the bed, tapping the latter amount into a ladle of that capacity from which I will take the tests necessary. Charcoal should be used as fuel until the desired metal is found, and then coke or anthracite coal used to determine their effect on the standard.

Table No. 1 gives the material to be used in the experiments: First is Swedish wrought iron the lowest in all the metalloids that combine with iron. Second, is low carbon steel, which is also low in the metalloids excepting in manganese. Third is ferro-manganese carrying 80 per cent manganese. Fourth is ferro-silicon, carrying 10 per cent silicon. Fifth is ferro-phosphorus or Aetna basic pig. Also on table No. 1 is a list of patterns for test-bars and pieces for different tests each heat having enough cast to submit the metal to all the chemical, physical and metallurgical tests.

TABLE NO. 1.

Material to be used in Making Experiments with Charcoal as Fuel.

	Carb.	Sili.	Phos.	Mang.	Sul.
1. Swedish Charcoal Wrought Iron..	.17	.05	.08	.00	.003
2. Low Carbon Steel Scrap	.15	.005	.05	.65	.005
3. Ferro-Manganese, 80 % Mang	6.50	.30	.20	80.	.00
4. Ferro-Silicon, 10 % Sil	2.	10.	.41	1.00	.002
5. Ferro-Phosphorus or Ætna Basic Pis	3.2	.75	2.25	.00	.00

TABLE II.

First Heat Carbon and Iron; Second, Third, Fourth and Fifth Heats, Carbon, Silicon and Iron.

Kind of Material Charged in Cupola.	Weight of Metal Charged.	Metalloids in Metals.					Unannealed.			Annealed.			Temperatures.			Temperature.	Nature of Metal.		Peculiarities of Fracture, etc.
		Carbon.	Silicon.	Phosphorus	Manganese	Sulphur	Tensile.	Transverse.	Torsion.	Tensile.	Transverse.	Torsion.	Tensile.	Transverse.	Torsion.		Chill.	Shrink.	
FIRST HEAT.																			
Swedish Wro't Iron..........	250	.17	.05	.08	.00	.003													
Analysis of Casting.																			
SECOND HEAT.																			
Swedish Wro't Iron..........	237½	.17	.05	.08	.00	.003													
Ferro Sil. 10 %................	12½	2.	10.	.20	1.20	.002													
Estimated Analysis..........			.50																
Analysis of Casting																			
THIRD HEAT.																			
Swedish Wro't Iron..........	225	.17	.05	.08	.00	.003													
Ferro-Sil. 10 %..............	25	2.	10.	.20	1.20	.002													
Estimated Analysis..........			1.00																
Analysis of Casting..........																			
FOURTH HEAT.																			
Swedish Wro't Iron..........	212½	.17	.05	.08	.00	.003													
Ferro-Sil. 10 %..............	37½	2.	10.	.20	1.20	.002													
Estimated Analysis..........			1.50																
Analysis of Casting.........																			
FIFTH HEAT.																			
Swedish Wro't Iron..........	200	.17	.05	.08	.00	.003													
Ferro-Sil. 10 %................	50	2.	10.	.20	1.20	.002													
Estimated Analysis..........			2.00																
Analysis of Casting																			

TABLE III.

Sixth, Seventh, Eighth and Ninth Heats, Carbon, Manganese and Iron.

Kinds of Metal Charged in Cupola.	Weight of Metal Charged.	Metalloids in Metals.					Unannealed.			Annealed.			Temperatures.			Degree of Heat.	Nature of Metal.		Peculiarities of Fracture, etc.
		Carbon.	Silicon.	Phosphorus.	Manganese.	Sulphur.	Tensile.	Transverse.	Torsion.	Tensile.	Transverse.	Torsion.	Tensile.	Transverse.	Torsion.		Chill.	Shrink.	
SIXTH HEAT.																			
Swedish Wro't Iron..........	250	.17	.05	.08	.00	.003													
Ferro-Mang. 80 %............	1.56¼	6.50	.30	.20	80.	.00													
Estimated Analysis..........																			
Anal. of Casting...					.50														
SEVENTH HEAT.																			
Swedish Wro't Iron..........	250	.17	.05	.08	.00	.003													
Ferro-Mang. 80 %............	3.12½	6.50	.30	.20	8 .00	.00													
Estimated Analysis..........																			
Anal. of Castings...........					1.00														
EIGHTH HEAT.																			
Swedish Wro't Iron..........	250	.17	.05	.08	.00	.003													
Ferro-Mang. 80 %............	4.78	6.50	.30	.20	80.	.00													
Estimated Analysis..........																			
Anal. of Casting....					1.00														
NINTH HEAT.																			
Swedish Wro't Iron..........	250	.17	.05	.08	.00	.003													
Fearo-Mang. 80 %	6.25	6.50	.80	.00	80.00	.00													
Estimated Analysis..........																			
Anal. of Casting........ ..					2.00														

In table No. 2, the first heat is simply "Swedish" wrought iron, which will pick up enough carbon in the cupola to give the value of carbon and iron. Heats Nos. 2, 3, 4 and 5 are the same as No. 1, with additions of silicon, commencing in No. 2 with :50 silicon and increasing by degrees to No. 5 to 2.00 per cent silicon. This series will determine the value of silicon alone with carbon and iron.

In table No. 3 we substitute manganese for silicon, starting in heat No. 6 with .50 manganese and increasing by degrees to heat No. 9, raising it to 2.00 per cent manganese. This series will determine the value of manganese alone with carbon and iron.

As silicon and manganese change their influence on the action of carbon and iron at different degrees of saturation, but in like proportion are opposite, there is a point where each changes, which, when ascertained, will be the point where the best re sults will be obtained for a basis for variation of percentage of either of these two.

In commencing our series of heats to ascertain the best combination of these two metalloids, we will use the low carbon steel instead of Swedish iron and ferro-silicon and manganese.

In table No. 4 we commence in heat No. 10 with silicon and manganese, the same at 1.00 per cent, and in the subsequent heats Nos. 11, 12 and 13, we keep manganese at 1.00 per cent and increase the silicon in each heat .50 per cent, until we reach 2.50 silicon. This series will determine the value of silicon and manganese with carbon and iron with varying proportions of silicon.

In table No. 5, heats Nos. 14 and 15, the silicon is reduced to .75 and .50 per cent, the manganese remaining at 1.00 per cent. In heats Nos. 16 and 17 silicon remains at 1.00 per cent, and manganese is varied to 1.50 per cent and 2.00 per cent. These different variations will make themselves manifest in the tests.

In table No. 6, heat No. 18, we commence with silicon and manganese at 1.00 per cent and add 1.00 per cent phosphorus, and in heats Nos. 19, 20 and 21 the proportions of phosphorus are increased until we have 2.50 per cent. This will show us the

influence phosphorus has carrying with it the same amount of silicon and manganese.

These experiments, in connection with phosphorus, can be made to an advantage by changing the percentage of the other metalloids to ascertain with which it exerts the best influence.

As the material charged into the cupola is analyzed, and each heat has an estimated analysis of the total amount of each ingredient present, and as the castings from these heats are analyzed and placed in their place on the tables, it will be clearly shown the loss or gain in the cupola and which special metalloid or combination of them produces peculiar effects. We will also have clearly demonstrated by our table the effects of the metalloids and their combinations upon the physical, chemical and metallurgical tests, determining the practical value of each or a combination of the metalloids in making cast iron in a cupola.

PATTERNS TO BE USED FOR TEST BARS AND PIECES.

1. For fluidity in casting and
2. Toughness when annealed.
3. 1" □ bar for transverse and torsion strength.
4. For tensile, turning 1½" bar to 1" area.
5. For tensile, just as it was cast.
6. Angle bar, to test solidity and segregation.
7. Chill block cast with edge againt chill 6"x¼"x1½".
8. For machining and turning 4"x2"x24".

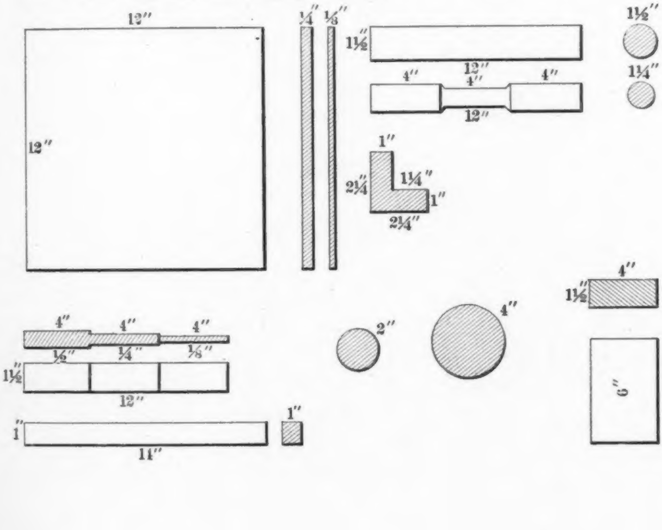

TABLE IV.

Tenth, Eleventh, Twelfth and Thirteenth Heats—Combinations of Carbon, Silicon, Manganese and Iron. Per Cent. of Silicon Increases, while Manganese Remains Stationary.

Kinds of Metal Charged in Cupola.	Weight of Metal.	Metalloids in Metals.					Unannealed.			Annealed.			Temperature.			Temperature.	Nature of Metal.		Peculiarities of Fracture, etc.
		Carbon.	Silicon.	Phosphorus.	Manganese.	Sulphur.	Tensile.	Transverse.	Torsion.	Tensile.	Transverse.	Torsion.	Tensile.	Transverse.	Torsion.		Chill.	Shrink.	
TENTH HEAT.																			
Low Carbon Steel............	225	.15	.005	.05	.65	.005													
Ferro-Sil. 10 %...............	25	2.00	10.	.20	1.20	.002													
Ferro-Mang. 80 %.......	3.13	6.50	.8	.20	.80	.00													
Estimated Analysis..........																			
Analysis of Casting.			1.00		1.00														
ELEVENTH HEAT.																			
Low Caabon Steel...........	212¼	.15	.005	.05	.65	.005													
Ferro-Sil. 10 %........	37½	2.00	10.	.20	1.20	.002													
Ferro-Mang. 80 %.....	3.13	6.50	.30	.20	80.	.00													
Estimated Analysis.....																			
Analysis of Casting..			1.00		1.00														
TWELFTH HEAT.																			
Low Carbon Steel......... ...	200	.15	.005	.05	.65	.005													
Ferro-Sil. 10 %..............	50	2 00	10.	.20	1.20	.002													
Ferro-Mang. 80 %...........	3.13	6.50	.30	.20	80.	.00													
Estimated Analysis..........																			
Analysis of Casting........			2.00		2.00														
THIRTEENTH HEAT.																			
Low Carbon Steel......	175	.15	.005	.05	.65	.005													
F ero-Sil. 10 %...............	75	2.00	10.00	.20	1.20	.002													
Fe rro-Mang. 80 %......	3.13	6.50	.30	.20	80.	.00													
Estimated Analysis..........																			
Analysis of Casting			2.50		1.00														

TABLE V.

In Fourteenth and Fifteenth Heats, Silicon Decreases, Manganese Stationary; Sixteenth and Seventeenth Heats, Manganese Increases, Silicon Stationery.

Kinds of Metals Charged in Cupola.	Weight of Metal Charged.	Metalloids in Metals.					Unannealed.			Annealed.			Temperatures.			Temperatures.	Nature of Metals		Peculiarities of Fracture, etc.
		Carbon.	Silicon.	Phosphorus.	Manganese.	Sulphur.	Tensile.	Transverse.	Torsion.	Tensile.	Transverse.	Torsion.	Tensile.	Transverse.	Torsion.		Chill.	Shrink.	
FOURTEENTH HEAT.																			
Low Carbon Steel	231¼	.15	.005	.05	.6	.005													
Ferro-Sil. 10%	18¾	2.00	10.	.20	1.20	.002													
Ferro-Mang. 80%	8.13	6.50	.30	.20	80.	.00													
Estimated Analysis																			
Analysis of Casting			.75		1.00														
FIFTEENTH HEAT.																			
Low Carbon Steel	237½	.15	.005	.05	.65	.005													
Ferro Sil. 10%	12½	2.00	10.	.20	.20	.002													
Ferro-Mang. 80%	8.13	6 50	.30	.20	80.	.00													
Estimated Analysis																			
Analysis of Casting			.50		1.00														
SIXTEENTH HEAT.																			
Low Carbon Steel	225	.15	.005	.05	.65	.005													
Ferro-Sil. 10%	25	2.00	10.	.20	1.20	.002													
Ferro-Mang. 80%	4.78	6.50	.30	.20	80.	.00													
Estimated Analysis																			
Analysis of Casting			1.00		1.50														
SEVENTEENTH HEAT.																			
Low Carbon Steel	225	.15	.005	.05	.65	.005													
Ferro-Sil. 10%	25	2.00	10.	.20	1.20	.002													
Ferro-Mang. 80%	6.25	6.50	.30	.20	80.	.00													
Estimated Analysis																			
Analysis of Casting			1.00		2.00														

TABLE VI.

In Eighteenth, Nineteenth, Twentieth and Twenty-First, Phosphorus Increases, Manganese and Silicon Remain Stationary.

Kind of Metal Charged in Cupola.	Weight of Metal.	Metalloids in Metals.					Unannealed.			Annealed.			Temperatures.			Temperature.	Nature of Metals.		Peculiarities of Fracture, etc.
		Carbon.	Silicon.	Phosphorus.	Manganese.	Sulphur.	Tensile.	Transverse.	Torsion.	Tensile.	Transverse.	Torsion.	Tensile.	Transverse.	Torsion.		Chill.	Shrink.	
EIGHTEENTH HEAT.																			
Low Carbon Steel	225	.15	.005	.05	.65	.005													
Ferro-Sil. 10 %	25	2.00	10.	.20	1.20	.002													
Ferro-Mang. 80 %	3.13	6.60	.30	.20	80.	.00													
Phosphorus	2½			2.50															
Estimated Analysis			1.00	1.00	1.00														
Analysis of Casting																			
NINETEENTH HEAT.																			
Low Carbon Steel	225	.15	.005	.05	.65	.005													
Ferro-Sil. 10 %	25	2.00	10.	.20	1.20	.002													
Ferro-Mang. 80 %	3.13	6.56	.30	.20	80.00	.00													
Phosphorus	3.75			3.75															
Estimated Analysis			1.00	1.59	1.00														
Analysis of Casting																			
TWENTIETH HEAT.																			
Low Carbon Steel	225	.15	.005	.05	.65	.005													
Ferro-Sil. 10 %	25	3.00	10.	.20	1.20	.002													
Ferro-Mang. 80 %	3.13	6.50	.30	.20	80.	.00													
Phosphorus	5.00			5.00															
Estimatdd Analysis			1.00	2.00	1.00														
Analysis of Casting																			
TWENTY-FIRST HEAT.																			
Low Carbon Steel	225	.15	.005	.05	.65	.005													
Ferro-Sil. 10 %	25	2.00	10.	.20	1.20	.002													
Ferro-Mang. 80 %	3.13	6.50	.30	.20	80.	.00													
Phosphorus	6.25			6.50															
Estimated Analysis			1.00	2.50	1.00														
Analysis of Casting																			

DISCUSSION.

Mr. R. N. Dickman, who was called upon, said: While I appreciate your courtesy, I feel at the present time I am a little too rusty on this subject to speak of it. Some year and a half ago I had the pleasure—as well as a small amount of labor—of going through an analogous set of experiments for Mr. Keep, but about that time my attention was turned into a different channel of work and since then I have not been doing much in that line. I may state, however, that both for the scientific interest that we take in such matters, and for the general good that seems apt to result from a systematic investigation of the influence of these metalloids, Mr. Mackenzie and myself will offer to this association our assistance in these experiments, and assure you that our part of the work shall receive our best attention, and the benefit of our experience in the chemical part.

Mr. John Pettigrew: Away back in the sixties one of the smartest men in the country took hold of pig iron and this was Gen. Rodman. He took hold of the Ft. Pitt foundry and made a very decided success in casting his cannon. He had the United States Government at his back. His idea was to have the outer coat of the gun keep a tight hold of the inner coat, and he was successful. He was the first man that ever introduced water into the cores, and he did it successfully. After the cannon was cast he turned on a stream of water right into the core and tested the temperature of the water until the gun was thoroughly cold. At the same time he governed the fire on the outside of the cast to keep the outside of the gun hot. Most of you gentlemen that have seen castings broken have noticed that the castings straighten out instead of rolling up. Gen. Rodman's guns always rolled up when broken.

Mr. A. Sorge, Jr.: The paper outlines a very exhaustive and complete line of work, which should be taken up by the Western Foundrymen's Association. The determination of the exact effect of the varying percentages of each metalloid in cast iron has been attempted partially by various experimenters, but there has never been a systematic series of experiments made

on this subject. Everyone of us that mixes iron for castings and uses chemistry in doing this has a theory of his own on which he works to produce certain results. Maj. McDowell has his and I have mine. Whether they agree or not I do not know. It is a matter of shop secret and each man keeps that thing to himself. I do not think this is best, however. I think that sort of thing is improved very materially by discussion and whatever theory an individual has can only be based on his own limited knowledge. But if the work outlined by Maj. McDowell in his paper is carried out, it will give us a series of demonstrations that will enable us to state intelligently what the exact effect of each one of the metalloids will be. I consider it so valuable a paper that I think our association should take it up by appointing a committee for the purpose of carrying out these experiments. It is going to be a matter of considerable expense and one that the association must not lose patience about. It will take one, two, or three years, possibly more, to work this out and the chances are that they will find great difficulty in obtaining the mixtures containing the exact amounts of the different metalloids desired, and it is going to take patience to get them. I think it is the most important thing, without exception, that is to-day before the foundrymen and I hope to see the Western Foundrymen's Association take hold and carry it through to a successful issue. I believe it can be done. As to entering into the details that Maj. McDowell has brought forward, I think it is too early to theorize. I think that, until we have these experiments before us and have the results in tabulated shape so that we can intelligently look them over, we had better not theorize. There was another point which I failed to make. Mr. Dickman spoke of the series of experiments made by Mr. Keep. These papers have not yet come out, but they will at the next meeting of the A. S. M. E. We have received parts of them, but the fact is that the line of experiments was entirely in the direction of demonstrating the effect of silicon. Even there the tests were made to establish a standard of test bars more than to demonstrate the effect of the various metalloids.

Mr. W. N. Moore: I thoroughly agree with the writer of the

paper on the desirability and necessity of the work that he has outlined, and I sincerely hope that this association can be instrumental in carrying it out. I, from my limited experience, have reason to doubt what little I sometimes think I know about the subject, and for the reason that there are so many combinations of elements dealt with that when one thinks he has arrived at a point where he knows something and can put a peg down, before he has gone much further he finds that the thing he thinks was true is true only under certain conditions. As an illustration of that: Some time ago we had trouble in our castings from shrink spots. The castings to which I refer are light castings and the shrink spots occurred where there were lugs or extra thickness. We found that we were running low in phosphorus, about one-half of one per cent. Our silicon was what we considered normal, between two and one-half and three per cent. We put our phosphorus up about one-quarter of one per cent, and we found that our trouble disappeared. There was no other change in the conditions. We set a peg down there that one-half of one per cent phosphorus is liable to produce shrink spots and that three-quarters of one per cent is all right. Well, that stood as good law until recently when my attention was called to a casting which had those identical shrink spots in it and an explanation was asked to account for them. I said it looked like low phosphorus. The casting was analyzed and showed three-quarters of one per cent phosphorus. The law was good until we struck some other combination and then the law did not hold. There was a very remarkable thing in connection with that casting. The sulphur was down to .035, which was extraordinarily low for light castings. Whether that was the changed condition that produced the result or not I do not know, and that is not the point I want to raise to-night. I mention it to show how necessary is a comprehensive study of the elements in cast iron. I trust that the result from the reading of this paper will be that this association will take hold of this work and stick to it until we do know something positive about the relations of the metalloids in cast iron.

Mr. Sorge: I feel that it is due to Maj. McDowell to make the explanation that he has stated to me that he hopes the Western Foundrymen's Association will take hold of this matter, but that he intends to go ahead with it himself, if the association does not. I think that it is a very laudable ambition on his part, but I think he will have an awful job to do it alone.

Maj. McDowell: This has been a subject that I have given a good deal of study, to ascertain what the state of the art was in this country as well as in the rest of the world, to see if I could not learn what had been done, so that if possible I could get hold of some place where others had left off. I here give a table showing eight heats that were made in England in a hot air furnace, and two made by myself at home in a cupola:

	Number of Heat.									
	1	2	3	4	5	6	7	8	9	10
Total Carbon	1.98	2.00	2.09	2.21	2.18	1.98	2.23	2.91	2.71	3.12
Uncombined Carbon	0.38	0.10	0.24	0.50	1.62	1.19	1.43	1.31	1.62	2.19
Combined Carbon	1.62	1.90	1.85	1.71	0.56	0.68	0.80	0.20	1.09	0.93
Silicon	0.19	0.45	0.66	1.37	1.96	2.25	2.96	3.92	0.94	1.34
Manganese	0.14	0.21	0.26	0.00	0.60	0.75	0.80	0.84	0.60	1.25
Tensile strength per sq. in.	22,000	27,000	28,000	31,000					32,000	49,000

Eight of the ten different heats given in the foregoing table were taken from Howe's "Metallurgy of Steel," the other two heats I made. The first eight were evidently made in a hot air furnace, while the last two were made in a cupola. Howe says, in reference to the eight heats: "As silicon rises beyond 1 4-10 the percentage of graphite at first increases rapidly, then falls off slowly, while tensile and compressive strength both decline uninterruptedly, while experience shows that no one set of observations on the effect of foreign elements on iron is conclusive. Turner's results are so harmonious as to inspire confidence." The experiments of Mr. Thomas Turner here referred to are extremely interesting, but are not satisfactory, because they treat of iron made in a hot air furnace, and their results do not reach the quality of iron made in a cupola. As the general foundry practice in this country is with a cupola,

what we want is the value of the different metalloids in combination with iron and carbon in making castings from metals melted in a cupola. The quality of our iron castings depends on the amount of carbon there is in them and its relation to the iron whether combined or uncombined. The two metalloids most seriously affecting these relations are manganese and silicon, the former intensifying the affinity iron has for carbon, while the latter under certain conditions eliminates and uncombines the carbon. Iron's capacity for absorbing carbon alone is limited to about 4.50 per cent, but when manganese is present in sufficient quantities it will carry from 6.50 to 7.50 per cent and when chromium is substituted for manganese it will carry from 10 to 12 per cent in combination. Iron has a greater affinity for silicon at certain temperatures than it has for carbon and will absorb it to carbon's exclusion, so that silicon pig carrying from 8 to 10 per cent silicon has less than two per cent carbon. Where iron is low in carbon, say less than 2.5 per cent and silicon 1.25 per cent or less, the carbon will remain combined, but when the combined amounts of carbon and silicon are over four per cent graphite carbon is formed. No one knows the true value of the metalloids in iron. I have succeeded in making some first-class metal. I would like to tell you what the mixture was for the next time it was tried it might not do it. Therefore I had decided to go ahead with a series of experiments, feeling sure that there are a large number of institutions in this country that would be only too glad to take up a part of this work. I came to the Western Foundrymen's Association feeling this. It is one of the bright things in the world to know that there is an association of men, who, like myself, are making iron. If we can form a combination of individuals out of this association to carry on these experiments it will be of very great value to the entire foundry industry.

Mr. Sorge moved that a committee of three be appointed by the chair to carry on a series of tests and experiments to determine the practical value of the metalloids in cast iron, and to carry on this work under the direction of the board of directors

of the Western Foundrymen's Association. The motion was duly seconded by Mr. Pettigrew and passed by the association.

The president appointed the following as members of this committee: A. Sorge, Jr., Maj. Malcolm McDowell, and John K. Mackenzie.

A vote of thanks was tendered Maj. McDowell for his paper. A vote of thanks was also tendered Messrs. Dickman and Mackenzie for offering their services in the work. The meeting then adjourned.

NEW ENGLAND FOUNDRYMEN'S ASSOCIATION.

The regular monthly meeting of the New England Foundrymen's Association was held at the Rockland House, Nantasket Beach, Wednesday, July 8th, there being twenty-two members present.

The Richmond Stove Company, of Norwich, Conn., and Theodore H. Colvin, Providence, R. I., were elected to membership.

The following papers were read by different members of the Association and discussed by those present:

DRY SAND CORES.

It is essential to make dry sand cores to conform with the mold they are designed for. To make cores for heavy work, that will stand without the iron fusing, the sand must be of a refractory substance. I find what we call a Jersey sand, high in silicon and clay, to stand the best. This is mixed with rye meal and clay wash, 12 parts Jersey fire sand, 4 parts of coarse molding sand, 1 of meal, and wet with one-half returns and one-half clay wash. After cores of this mixture have been baked, I give them a wash while hot, of common facing sand mixed with clay wash and returns, thin enough to be put on with a brush. After this is dried, black with a mixture of 2 parts lead, and one part mineral. This mixture works well on a cylinder jacket and port cores, giving the cores a hard and firm surface, yet one the iron will lay to without bad effects.

When a core has to stand a great amount of heat, I find it works very well to give them a coating of white lead and whitening, mixed together. I have used asbestos in different ways, in the powder mixed with oil, and in the paper or sheet form, but have never found it a success. I have used it to split small pulleys with, but I find the iron does not lay to it as well as to sand. I have tried several compounds and core mixtures, but have never found anything that would take the place of sand and meal.

I find a standard mixture of 16 parts of bank sand, and one of meal, wet with returns gives the best results for general work. This mixture can be changed, using from 12 to 20 to 1, according to the class of work the cores are required for. Where a fine surface is required a mixture of common molding sand, wet with returns with a small amount of flour, gives a very nice core for small work. Resin cores have been tried and I think have not proved a success.

Different foundrymen have different mixtures, yet we all have to use binder enough to hold our cores together in a firm and good form, not forgetting, that too much binder creates gas, which we try to avoid all we can.

My opinion is that we all use too much binder, or we are not getting the benefits of what we do use. In the first place we use meal or flour to give the cores strength.

How does it give them strength? My opinion is this: Meal or flour is an organic matter, and is composed of about 75 per cent of starch. Its chemical combination is carbon, hydrogen and oxygen, and when mixed with water is of a sticky nature.

When a batch of core sand is mixed, the starch is supposed to connect itself with the sand, to hold it or give to it the strength. Now this is placed in the oven to bake, in order that the starch may do its work as it should. Just think of the care that should be taken of the oven to keep it at the right temperature. As I have said, the chemical combinations are all combustibles of the highest order, having no strength when reduced to carbon, if put to a great heat. Now if our oven is

too hot at any one time, what is the effect? The gluten is destroyed at once, and the starch reduced to carbon cinder, without the strength of ash, and all the binder that is left in our cores is that which was deposited in the sand by nature.

In order to overcome this, and get the best results from our ovens, and binder, we should have our ovens so that no flame should be inside, but regulated with dampers in such a way as to give the oven just the required temperature at all times to bake and harden the gluten without destroying any of it.

A baker has to be very careful of his oven to keep just such a heat. They receive the best results by building up their fire, getting their oven to just such a heat, then the fire is drawn, the drafts all closed, and the oven is then ready to do its work without any damage to the gluten. He could not bake anything with the flame in the oven; it would not have that toughness and would lose all its properties that we are anxious to retain. Now to overcome it in our ovens—we do not always destroy the binder, but we have to use enough to allow some to be destroyed and still have enough left to give the cores the required strength. We give the cores a coating of molasses or returns and water. In doing this we are only applying more starch. For all the benefit we receive from this is the organic matter that is deposited there.

It is a question, which is the cheaper, returns or molasses? To determine this they should be analyzed to find which contains the most organic matter, and reduced accordingly, then compare the cost.

Meal, flour, returns and molasses, all contain organic matter, which is the binder that we require. This, I think, one reason why we cannot find a substitute for meal and sand, as it is the cheapest way in which starch can be obtained. From oil we may obtain the same result, yet it does not possess the amount of gluten that there is to meal.

It is clear to me that a saving might be made in our mixtures, also a better core, if we could use less of this organic matter (which creates so much gas), if we gave our ovens the care that a baker gives his. A piece of macaroni is nothing

but a starch paste, but the secret of making it lies in the way in which it is dried and baked, yet it has great strength. I prefer meal to flour, as rye meal contains only its own bran to each kernel of wheat, while this cheap flour is made from the bran of the kernels that have been used for the best flour. It is a trade in itself for millers to produce this cheap flour with the bran of good wheat, with a percentage of good wheat added.

So I think the meal would produce the more starch, as the starch is found in the center of the kernel. It is the starch we want, and nothing else.

Regarding sands, I prefer inland bank sand, as it is free from salt. Salt collects dampness when left in the molds. I think clay wash one of the greatest benefits in core-making, where we are apt to destroy our binder. A good coat of clay wash over a core will keep the air away from the binder. This helps to protect it, and in a measure allows it to do its work before being destroyed by the heat.

If the binder is allowed to take on its crystalized form, it becomes more refractory and will stand a much greater heat.

APPRENTICES.

(PAPER No. 1.)

I have been asked to write a paper on this subject to be read at our meeting. I hardly know what to say that is not known by all foundrymen.

I think it is a fact that all foundrymen acknowledge, that we want and need all the good molders that can be had.

There is a superabundance of medium and poor molders, but a scarcity of good ones at almost all times.

If every foundry would take in all the apprentices that it could, and would teach them properly, in a few years there would be more and better molders for us to choose from than at present.

When a boy has worked a few weeks and proved shiftless and takes no interest in his work, it is better for the boy and trade in general if he is discharged and a new one taken on in his place.

After a boy has worked a few months he should be given work upon the bench or floor and given a plain job, and shown by the foreman how to make that piece, then let him work on it until the order is out.

He should then be taught to make something else, and encouraged to make good castings by giving him variety, and not kept at one job for weeks at a time because it pays a little better.

I do not think it is right to keep a boy making grate bars and flat backs until his time is out, or he has lost all ambition and is called by the foreman no good.

If a boy is taught as he should be, that the last year of his apprenticeship he should be expected to do as good and as much work as a journeyman, then the foundry can profit for the labor expended in teaching him in his earlier days.

(PAPER No. 2.)

The apprenticeship question is one I know we are all interested in. I would like to call your attention to the system of taking a young man into the foundry, and making a molder of him in three years. I think the time is too short; that is my experience in the foundry. In the first place he has only got the rudiments, and must put them in practice at some foundryman's expense. As we know, he will demand union wages as soon as his three years expire, and in order to protect ourselves we ought to insist on a four years' apprenticeship.

The first year you can use him to advantage on the core bench, as that is a part of the business that molders ought to understand. The question is often asked, Where do all the poor molders come from? I think it can be answered in a general way. There is the runaway apprentice and specialty molder, and sometimes a stove plater. When they get into a jobbing shop we all know the result.

Some foundrymen say we have not got as good material to make molders of as was in years gone by, and we must admit that the bright intelligent young men of to-day are not learning the molder trade, but we must take them as we find them.

I should like to have this question discussed for our mutual benefit at the next meeting.

A REVIEW OF THE FOUNDRY LITERATURE OF THE MONTH.

AMERICAN MACHINIST.

July 9—Has an illustrated article from the pen of C. Vickers, containing some hints on brass foundry work. Mr. Vickers describes the method shown for pouring some heavy pieces for that metal, as well as for making some brass molds or dies to be used in pouring white metal work. It is necessary that these dies, which contain a great deal of floral and detail work, should be very fine castings, consequently the molds had to be perfect, and his explanation of how it was done will prove of interest to brass foundrymen.

July 16—One of its correspondents furnishes a drawing of a casting which he calls a "helix," which is a casting of rather a peculiar shape, resembling a shaft with a spiral wound around its exterior, and on which he wishes some information concerning the best way to mold.

July 23—In this issue B. F. Chambers writes entertainingly in regard to cupola work, in which he makes the rather astonishing statement that the climate of New Jersey, Montana and Illinois all differ so radically that they materially affect the operation of melting, and that the difference is very noticeable.

July 30—Has an article from the pen of an anonymous correspondent on the subject of molding machines. The writer takes a very optimistic view of the value of these machines for many classes of work, and claims that upon many forms of casting the machine will do 40 per cent more work than can be done by hand.

THE IRON AGE.

July 23—Refers editorially and at length to the good work done by the Western Foundrymen's Association recently, and refers especially to their having undertaken a series of elaborate experiments to determine the value of cast iron metalloids.

It is an undertaking that is likely to require a long time to enable the interested parties to give it the amount of thorough research necessary, and as it is one that will be of very great value to everyone in the manufacture or consumption of pig iron, they point out very clearly the benefit to be derived.

IRON TRADE REVIEW.

July 16—Has a whole page article, with four illustrations showing a hand molding machine, which was patented by Frank J. Scott, of Chicago, and intended to be used in molding plain, light castings.

With the aid of the machine shown it is said that 18,000 gears of a certain size were made without any repairs whatever to machine or pattern, and with another machine of a somewhat similar design two laborers molded, and with the assistance of four others, poured 64 flasks of brake shoes in nine hours, each flask containing four shoes, weighing 30 lbs. each, or a total of 7,680 lbs. of brake shoes molded and poured in nine hours by two men.

The article describes all the working parts of the machine in detail, giving sectional views of the parts.

THE FOUNDRY

For the month of July contains among other features an article covering about 4 1-2 pages, illustrated with eleven engravings from the pen of Henry Hansen on the manufacture of cast iron radiators. This is the continuation of an article commenced in the May issue of the same paper.

Mr. Hansen goes into the subject pretty thoroughly, and he has probably written more entertainingly on this subject than anyone has heretofore.

W. L. Hayden has an article illustrated with four engravings, on the subject of "Cast Iron Grafting," explaining the method adopted in their foundry on the subject of burning necks and wobblers on rolls.

Mr. W. J. Keep contributes over two pages to his series under the title of "Cast Iron Notes." In this issue he describes at length the subject of "How to Gain Knowledge of Cast Iron."

Twining Campbell has an article on the subject of "Aluminum Bronze."

Mr. Henry Hansen has an entertaining article entitled the "Delusive Grate Bar," in which he rather makes light of the usual assumption that these are a class of castings that almost anyone can make, and incidentally enlarges upon the necessity of care and ability to perform every operation undertaken in the iron foundry.

There are some good illustrations of the President and Treasurer of the American Foundrymen's Association, together with a brief biographical sketch of both gentlemen. Under the head of "Correspondence," Messrs. A. Sorge, Jr., and C. E. Stone describe the subject of humidity of the atmosphere and its effect on cupola work, while Mr. F. B. Shaffer refers at length to the growth of foundry literature, and the increased amount of attention given to foundry subjects.

The subject of transparent, non-breakable window glass especially suitable for foundry purposes receives some consideration, and is also illustrated with two half-tone engravings in a description of the product of the Translucent Fabric Co.

There are several interesting features in this issue besides those enumerated.

IRON MOLDERS' JOURNAL.

The Journal of the Iron Molders' Union for the month of July contains portraits and biographical sketches of the members of the Executive Board of their organization, together with an article on the manufacture of sheave pulleys, by T. A. Haight, and an anonymous communication concerning some valuable hints on the method of conducting an iron foundry.

MACHINERY.

July, 1896—Devotes a page describing and illustrating by plan sectional view a sand sifting machine. The description is by John L. Klindworth, and the illustrations shown, together with the descriptive matter, are sufficiently clear to enable anyone to make their own sand sifter, providing they are so inclined.

RAILWAY AGE.

July 31—Has one or two illustrations of steel foundry exhibits that are interesting in showing the progress that has been made in that direction.

The first one shows a drive wheel center made by the American Steel Casting Co., of Thurlow, Pa., with two of its spokes broken out and twisted, showing the remarkable toughness of the steel used and its very evident adaptability for that purpose.

Another one gives a view of the exhibit of the American Steel Foundry Co. of St. Louis, at the Saratoga meeting of the Master Mechanics' Association, and the descriptive matter explains in an interesting way the nature of the car work made in steel by this firm.

Both of these exhibits were among those shown at the Convention of the Master Mechanics' Association, held at Saratoga last June.

ACTIVE MEMBERS.

June 25, 1896—Abendroth Bros.......................Port Chester, N. Y.
July 9, 1896—Aermotor Co............12th, Rockwell & Fillmore,
Chicago, Ill.
July 17, 1896—American Radiator Co..................Detroit, Mich.
June 29, 1896—Amsden, Alonzo D...............Phoenix Foundry,
Providence, R. I.
Sept. 14, 1896—Anniston Pipe & Foundry Co...........Anniston, Ala.

July 22, 1896—Babington, B. B.......B. B. Babington, Son & Co.,
Shelby, N. C.
July 10, 1896—Barbour-Stockwell Co...............205 Broadway,
Cambridgeport, Mass.
July 17, 1896—Beckett, James A..W. A. Wood Mowing & Reaping
Co., Hoosick Falls, N. Y.
June 28, 1896—Blackburn, A. H............Fuel Economizer Co.,
Matteawan, N. Y.
Sept. 10, 1896—Blymyer Iron Works Co., The........Cincinnati, Ohio.
July 13, 1896—Buffalo Forge Co.......................Buffalo, N. Y.

June 11, 1896—Campbell, Twining.....................Paterson, N. J.
Aug. 28, 1896—Cornegie Steel Co., The................Pittsburg, Pa.
July 20, 1896—Carpenter, A. & Sons.............272 W. Exchange,
Providence, R. I.
June 27, 1896—Cavanaugh, Francis......Quakertown Stove Works,
Quakertown, Pa.
June 20, 1896—Cheney & Son, S.....................Manlius, N. Y.
June 23, 1896—Choate, Chas. N.. Bridgeport, Deox., Bronze & Metal
Co., Bridgeport, Conn.
June 16, 1896—Colvin, Theo. H......Theo. H. Colvin Foundry Co.,
Providence, R. I.
June 21, 1896—Colorado Fuel & Iron Co.................Pueblo, Col.
July 1, 1896—Connersville Blower Co...............Connersville, Ind.
July 11, 1896—Condor Iron Foundry Co............East Boston, Mass.
June 26, 1896—Co-operative Foundry Co...............15 Hill St.,
Rochester, N. Y.
June 24, 1896—Corbin, P. & F.....................New Britain, Conn.

June 29, 1896—Davis Foundry Co....................Lawrence, Mass.
July 18, 1896—Day, F. M.................Hopedale Machine Co.,
Hopedale, Mass.
Aug. 24, 1896—Dickson Mfg. Co........................Scranton, Pa.
June 22, 1896—Dighton Furnace Co...................Taunton, Mass.
June 29, 1896—Donaldson, J. F........Ingersoll-Sergeant Drill Co.,
640 Wolf St., Easton, Pa.
June 19, 1896—Drummond Mfg. Co....................Louisville, Ky.
Sept. 7, 1896—Dry Dock Engine Works.................Detroit, Mich.

Aug. 26, 1896—Erie Malleable Iron Co., Ltd..................Erie, Pa.
July 1, 1896—Evans, Henry Clay....Mgr. Chattanooga Car & Fdy. Co., Chattanooga, Tenn.

June 28, 1896—Fisher, John E..Foreman Foundry, National Transit Co., Oil City, Pa.
July 1, 1896—Flagg, Stanley G. & Co..19th and Pennsylvania ave., Philadelphia, Pa.
Aug. 29, 1896—Flather, Frederick A........Lowell Machine Shop, Lowell, Mass.
June 25, 1896—Frank-Kneeland Machine Co..............54th St., Pittsburg, Pa.
Sept. 8, 1896—Frontier Iron Works......................Detroit, Mich.

June 18, 1896—Gibby, F. W......Prest. Mechanics' Iron Fdy. Co., 38 Kemble St., Roxbury, Mass.
July 11, 1896—Gillette-Herzog Mfg. Co.............Minneapolis, Minn.
July 1, 1896—Girard Iron Works...................22d & Master, Philadelphia, Pa.
July 5, 1896—Groves, S....................Taylor, Wilson & Co., Allegheny, Pa.

July 19, 1896—Hanson, Wm....5404 Lancaster ave., Philadelphia, Pennsylvania Iron Works Co., Philadelphia, Pa.
Aug. 26, 1896—Samuel F. Hodge & Co..................Detroit, Mich.
July 2, 1896—Hubley Mnfg. Co.......................Lancaster, Pa.

July 2, 1896—Ingersoll-Sergeant Drill Co........Havemeyer Bldg., New York, N. Y.

July 30, 1896—James, Geo............Mangr. Variety Iron Works, Seattle, Wash.
June 29, 1896—Jarecki Mfg. Co., Ltd., Foundry Dept.........Erie, Pa.
July 23, 1896—Jobb, Chas. L...............Londonderry Iron Co., Londonderry, N. S.
Sept. 2, 1896—Jones, E. H....................143 S. Franklin St., Wilkes-Barre, Pa.

June 18, 1896—Keep, Wm. J............Supt. Michigan Stove Co., 753 Jefferson Ave., Detroit, Mich.
June 22, 1896—Kimball, W. G..............S. G. Kimball's Sons, 127 Washington St., Newburgh, N. Y.
June 29, 1896—Kitchell, H. G.................Delta Machine Co., Greenwood, Miss.
June 29, 1896—Knoeppel, John C..Foreman Foundry Buffalo Forge Co., 540 Swan St., Buffalo, N. Y.
June 29, 1896—Koken, Wm. T.................Koken Iron Works, St. Louis, Mo.
July 9, 1896—Koons, Jos.........With L. V. R. R. Co., Weatherly, Pa.

June 16, 1896—Lane Mfg. Co..........................Montpelier, Vt.
June 27, 1896—Leechburg Fdy. & Mach. Co...........Lewis Blk., Pittsburg, Pa.
July 4, 1896—LeBaron Foundry Co.............Middleborough, Mass.
Sept. 19, 1896—Leland & Faulconer Mfg. Co.............Detroit, Mich
Sept. 2, 1896—Letchworth, O. P....Pres. Pratt & Letchworth Co., Buffalo, N. Y.
June 29, 1896—Lincoln, Geo. H. & Co...........South Boston, Mass.
July 11, 1896—Little, Owen J.....Propr. Deckertown Foundry and Machine Shops, Deckertown, N. J.
June 19, 1896—Lutterman, T. F. A..Foreman National Supply Co., 1422 Baxter St., Auburndale, O.

June 18, 1896—Magee Furnace Co......................Boston, Mass.
July 28, 1896—Maher & Flockhart.....................Newark, N. J.
July 3, 1896—Malleable Iron Fittings Co...........Brandford, Conn.
July 13, 1896—Mathes, Ph........Brittan, Graham & Mathes Co., 411 Wood St., Pittsburg, Pa.
Aug. 27, 1896—Matlack, David J..............2247 Richmond St., Philadelphia, Pa.
Sept. 21, 1896—McLagon Foundry Co...............New Haven, Conn.
Sept. 26, 1896—Michigan Malleable Iron Co.............Detroit, Mich.
Aug. 26, 1896—The Michigan Stove Co.................Detroit, Mich.
Aug. 31, 1896—Moore, D. G....Pres. The S. L. Moore & Sons Co., Elizabeth, N. J.
June 29, 1896—Morris & Barlow.........28 Orange St., Newark, N. J.
June 29, 1896—Morris, Wheeler & Co.........16th and Market Sts., Philadelphia, Pa.
July 8, 1896—Mosher Mfg. Co.........................Dallas, Tex.

July 10, 1896—Newburgh Ice Mch. & Eng. Co..Edgar Penney, Pres., Newburgh, N. Y.
June 23, 1896—Nicholas, W. H......Foreman of Foundry P. R. R., Renova, Pa.
July 20, 1896—Northwestern Malleable Iron Co........Milwaukee, Wis.
Sept. 24, 1896—North & Judd Mfg. Co............New Britain, Conn.

August 12, 1896—Olympic Iron Works...............Tacoma, Wash.
Aug. 26, 1896—D. M. Osborne & Co...................Auburn, N. Y.
June 25, 1896—Osgood & Hart....3 Sherman St., Charlestown Dist., Boston, Mass.

July 10, 1896—Patterson, Wm. E..Brown & Patterson, 33 Marcy Ave., Brooklyn, N. Y.
June 19, 1896—Penton, John A......Editor "Foundry," Detroit, Mich.
Sept. 22, 1896—Pittsburg Malleable Iron Co............Pittsburg, Pa.
July 15, 1896—Pratt & Whitney Co..................Hartford, Conn.

July 10, 1896—Ridgway, Craig & Son.................Coatesville, Pa.
July 18, 1896—Riehl, Wm......Nat. Fdy. & Mach. Co., Louisville, Ky.

June 19, 1896—Robinson-Rea Mfg. Co....329 Water St., Pittsburg, Pa.
June 19, 1896—Rohland, John..Supt. Coxe Iron Mfg. Co., Drifton, Pa.
July 8, 1896—Roots, P. H. & F. M., Co.............Connersville, Ind.
June 26, 1896—Russell & Erwin Mfg. Co...........New Britain, Conn.
June 17, 1896—Russel, John R......Sec'y Russel Wheel & Fdy. Co., Detroit, Mich.

Sept. 7, 1896—Sawyer, James C.........Somersworth Machine Co., Dover, N. H.
June 17, 1896—Schumann, Francis..Pres't Tacony Iron & Metal Co., Tacony, Pa.
June 27, 1896—Seaman-Sleeth Co.............41st St. and Willow, Pittsburg, Pa.
Aug. 31, 1896—Sellers & Co., Wm.....................Philadelphia, Pa.
Sept. 5, 1896—Sessions Foundry Co....................Bristol, Conn.
June 25, 1896—Sheppard, Isaac A. & Co............Philadelphia, Pa.
June 29, 1896—Shickle, Harrison & Howard Iron Co......St. Louis, Mo.
June 24, 1896—Sleeth, S. D..........Westinghouse Air Brake Co., Pittsburg, Pa.
July 1, 1896—Smith, Pemberton.........N. Y. Car Wheel Works, Buffalo, N. Y.
June 17, 1896—Sorge, A. Jr.................1533 Marquette Bldg., Chicago, Ill.
July 15, 1896—Springer, Jos. H.....Supt. Mich. Brass & Iron Works, Detroit, Mich.
July 13, 1896—St. Paul Foundry Co...................St. Paul, Minn.
Aug. 29, 1896—Stevens, W. W.....9th and Montgomery Ave., Philadelphia, Pa.
Aug. 29, 1896—Sweeney, John M..Pres't Consolidated Iron & Steel Co., Harvey, Ill.
June 1, 1896—Syracuse Chilled Plow Co...............Syracuse, N. Y.

July 13, 1896—Taft, C. A...................Whitin Machine Co., Whitinsville, Mass.
June 17, 1896—Taylor, Robt......Chairman Taylor-Wilson & Co., Allegheny, Pa.
June 17, 1896—Taylor-Wilson & Co., Ltd...............Allegheny, Pa.
July 8, 1896—Thompson, Josiah..............J. Thompson & Co., Philadelphia, Pa.
Aug. 26, 1896—Torrance Iron Co.........................Troy, N. Y.
June 27, 1896—Treat, C. A., Mfg. Co...................Hannibal, Mo.
July 18, 1896—Trenton Malleable Iron Co..............Trenton, N. J.

July 8, 1896—Walker & Pratt Mfg. Co.............Watertown, Mass.
July 20, 1896—Wallis, Philip.........M. M.; L. V. R. R., Hazleton, Pa.
June 19, 1896—Warden, King & Son....................Montreal, P. Q.
June 17, 1896—Waterbury-Farrell Foundry & Machine Co., Waterbury, Conn.

July 13, 1896—Watson, James....Otis Bros. & Co., 61 Hudson St., Yonkers, N. Y.

June 27, 1896—West, Thos. D..Vice-Pres. & Mngr. Thos. D. West Foundry Co., Sharpsville, Pa.

Sept. 2, 1896—Whitney, Asa W................1601 Callowhill St., Philadelphia, Pa.

July 3, 1896—Wilbraham-Baker Blower Co..........Philadelphia, Pa.

July 15, 1896—Wood, Walter...R. D. Wood & Co., 400 Chestnut St., Philadelphia, Pa.

Sept. 2, 1896—Worthington, Henry R..............Van Brunt St., Brooklyn, N. Y.

June 18, 1896—Yagle, Wm. & Co., Ltd.......32d St. & A. V. R. R., Pittsburg, Pa.

ASSOCIATE MEMBERS.

July 31, 1896—Andrew Bros.' Co..............Mnfrs. of Pig Iron
Youngstown, O.

July 12, 1896—Burget, R. A...Treas. and Gen. Mgr. Richmond Iron
Works, Richmond Furnace, Mass.

June 29, 1896—Dixon Crucible Co., Jos. Mfrs. Crucibles and Foundry
Facings, Jersey City, N. Y.

July 8, 1896—Findley, A. I..........Editor "Iron Trade Review,"
Cleveland, O.

Aug. 7, 1896—Garden City Sand Co..Molding Sand and Fire Brick,
Chicago, Ill.

June 17, 1896—Goodrich, F. A. & Co.............Pig Iron Dealers,
926 Chamber of Commerce, Detroit, Mich.

July, 1896—Gobeille Pattern Co.................Mfrs. of Patterns,
Cleveland, O.

July 11, 1896—Hanson & Van Winkle Co..Mfrs. of Foundry Nickel
Plating Outfits, Newark, N. J.

July 17, 1896—Howe, Arthur W..Pig Iron Dealer, 420 Bourse Bldg.,
Philadelphia, Pa.

July 10, 1896—Hussman Crucible Co..........Mfrs. of Crucibles,
810 Commercial Bldg., St. Louis, Mo.

July 6, 1896—Kirk, Dr. E...........................Philadelphia, Pa.

July 14, 1896—Kittanning Iron & Steel Mfg. Co.......Kittanning, Pa.

June 16, 1896—McCormick, J. S., Co.............Foundry Supplies,
Pittsburg, Pa.

July 20, 1896—McCullough & Dalzell Co.......Mfrs. of Crucibles,
Pittsburg, Pa.

July 10, 1896—Miller, Alfred J....Vice-Pres. Whitehead Bros.' Co.,
42 S. Water St., Providence, R. I.

June 29, 1896—Millett Core Oven Co....Mfrs. of Millett Core Oven,
Brightwood, Mass.

July 3, 1896—Obermayer, S., Co................Foundry Supplies,
Cincinnati, O.

July 6, 1896—Paxson, J. W. & Co...............Foundry Supplies,
Philadelphia, Pa.

July 20, 1896—Pettinos, Geo. F....Pettinos Bros., Foundry Facings,
Bethlehem, Pa.

July 7, 1896—Pickands, Brown & Co..Mfrs. & Dealers of Pig Iron,
Rookery Bldg., Chicago, Ill.

June 29, 1896—Pickands, Mather & Co. . Mfrs. & Dealers of Pig Iron,
Cleveland, O.

July 26, 1896—Rock Run Iron & Mining Co............Rock Run, Ala.
June 19, 1896—Rogers, Brown & Co.............Pig Iron Dealers,
New York, N. Y.
July 22, 1896—Rogers, Brown & Warner.........Pig Iron Dealers,
Bullitt Bldg., Philadelphia, Pa.

July 17, 1896—Tabor Mfg. Co., The........frs. Molding Machines,
Elizabeth, N. J.
Aug. 17, 1896—Taylor & Son, Robt. J...........Mfrs. of Crucibles,
Philadelphia, Pa.
July 14, 1896—Timmis & Clissold.................Bound Brook, N. J.
June 20, 1896—Translucent Fabric Co. . Mfrs. of Translucent Fabric,
Quincy, Mass.

Sept. 19, 1896—Washington Coal & Coke Co............Pittsburg, Pa.
June 30, 1896—Wells Light Mfg Co., The....Mfrs. of Wells Light,
44-46 Washington St., New York, N. Y.

LIST OF MEMBERS ARRANGED ALPHABETICALLY AS TO RESIDENCE.

ALABAMA.

Anniston—Anniston Pipe & Foundry Co.
Rock Run—Rock Run Iron & Mining Co.

COLORADO.

Pueblo—Colorado Fuel & Iron Co.

CONNECTICUT.

Brandford—Malleable Iron Fittings Co.
Bridgeport—Chas. N. Choate, Deox, Bronze & Metal Co.
Bristol—The Sessions Foundry Co.
Hartford—Pratt & Whitney Co.
New Britain—P. & F. Corbin....North & Judd Mfg. Co....Russell & Erwin Mfg. Co.
New Haven—McLagon Foundry Co.
Waterbury—Waterbury-Farrell Foundry & Machine Co.

ILLINOIS.

Chicago—Aermotor Co., 12th, Rockwell & Fillmore....Pickands, Brown & Co....Garden City Sand Co....A. Sorge, Jr., 1533 Marquette Bldg.
Harvey—John M. Sweeney, Pres't Consolidated Iron & Steel Co.

INDIANA.

Connersville—The Connersville Blower Co....P. H. & F. M. Roots Co.

KENTUCKY.

Louisville—The Drummond Mfg. Co....Wm. Reihl, National Foundry & Machine Co.

MASSACHUSETTS.

Boston—Magee Furnace Co....Osgood & Hart, 3 Sherman St., Charlestown Dist.
Brightwood—Millett Core Oven Co.
Cambridgeport—Barbour-Stockwell Co.
East Boston—Condor Iron Foundry Co.
Hopedale—F. M. Day, Hopedale Machine Co.
Lawrence—Davis Foundry Co.
Lowell—Frederick A. Flather, Lowell Machine Shop.
Middleborough—LeBaron Foundry Co.
Quincy—Translucent Fabric Co.
Richmond Furnace—R. A. Burget, Treas. & Gen. Mgr. Richmond Iron Works.

Roxbury—F. W. Gibby, 38 Kemble St.
South Boston—Geo. H. Lincoln & Co.
Taunton—Dighton Furnace Co.
Watertown—Walker & Pratt Mfg. Co.
Whitinsville—C. A. Taft, Whitin Machine Co.

MICHIGAN.

Detroit—American Radiator Co....Dry Dock Engine Works....Frontier Iron Works....F. A. Goodrich & Co....Samuel F. Hodge & Co.... Wm. J. Keep, Supt. Michigan Stove Co....Leland & Faulconer Mfg. Co....The Michigan Malleable Iron Co....The Michigan Stove Co....John A. Penton, Editor "Foundry"....John R. Russel, Sec'y Russel Wheel & Foundry Co....Jos. H. Springer, Supt. Michigan Brass & Iron Works.

MINNESOTA.

Minneapolis—Gillette-Herzog Mfg. Co.
St. Paul—St. Paul Foundry Co.

MISSISSIPPI.

Greenwood—H. G. Kitchell, Delta Machine Co.

MISSOURI.

Hannibal—C. A. Treat Mfg. Co.
St. Louis—Hussman Crucible Co.; Wm. F. Koken. Koken Iron Works.

NEW HAMPSHIRE.

Auburn—D. M. Osborne & Co.
Dover—James C. Sawyer, Somersworth, Mch. Co.
Scranton—Dickson Mfg. Co.

NEW JERSEY.

Bound Brook—Timmis & Clissold.
Deckertown—Owen J. Little, Prop. Deckertown Foundry & Machine Shops.
Elizabeth—The Tabor Mfg. Co....D. G. Moore, Pres. The S. L. Moore & Sons' Co.
Jersey City—Jos. Dixon Crucible Co.
Newark—Honson & Van Winkle Co....Maher & Flockhart....Morris & Barlow, 28 Orange St.
Paterson—Twining Campbell.
Trenton—Trenton Malleable Iron Co.

NEW YORK.

Brooklyn—Wm. E. Patterson, 33 Marcy Ave....Henry R. Worthington, Van Brunt St.

Buffalo—Buffalo Forge Co....John C. Knoeppel, foreman Buffalo Forge Co., 540 Swan St....Pemberton Smith, New York Car Wheel Works....O. P. Letchworth, Pres. Pratt & Letchworth Co.
Hoosick Falls—Beckett A. James, W. A. Wood Mowing & Reaping Co.
Manlius—S. Cheney & Son.
Matteawan—A. H. Blackburn, Fuel Economizer Co.
Newburgh—W. G. Kimball, 127 Washington St.....Newburgh Ice Machine & Engine Co.
New York—Ingersoll-Sergeant Drill Co., Havemeyer Bldg....Rogers, Brown & Co....The Wells Light Mfg. Co., 44-46 Washington St.
Port Chester—Abendroth Bros.
Rochester—Co-operative Foundry Co., 15 Hill St.
Syracuse—Syracuse Chilled Plow Co.
Troy—Torrance Iron Co.
Yonkers—James Watson, Otis Bros & Co., 61 Hudson St.

NORTH CAROLINA.

Shelby—B. B. Babington, B. B. Babington, Son & Co.

OHIO.

Auburndale—T. F. A. Lutterman, Foreman National Supply Co., 1422 Baxter St.
Cincinnati—The Blymyer Iron Works Co....S. Obermayer Co.
Cleveland—A. I. Findley, Editor "Iron Trade Review"....Gobeille Pattern Co....Pickands, Mather & Co.
Youngstown—Andrews Bros.' Co., Mfrs. of Pig Iron.

PENNSYLVANIA.

Allegheny—S. Groves, Taylor, Wilson & Co....Robert Taylor, Chairman Taylor, Wilson & Co....Taylor, Wilson & Co., Ltd.
Bethlehem—Geo. F. Pettinos.
Coatesville—Craig-Ridgway & Son.
Drifton—John Rohland, Supt. Coxe Iron Mfg. Co.
Easton—J. F. Donaldson, 640 Wolf St.
Erie—Jarecki Mfg. Co., Ltd....Erie Malleable Iron Co., Ltd., Box 485.
Hazelton—Philip Wallis, M. M.; L. V. R. R.
Kittanning—Kittanning Iron & Steel Mfg. Co.
Lancaster—Hubley Mfg. Co.
Oil City—John E. Fisher, Foreman Foundry, National Transit Co.
Pittsburg—The Carnegie Steel Co., Ltd....Frank-Kneeland Machine Co....Leechburg Foundry & Machine Co....Ph. Mathes, 411 Wood St., Brittan, Graham & Mathes Co....J. S. McCormick Co....McCullough & Dalzell Co....Pittsburg Malleable Iron Co....Robinson-Rae Mfg. Co., 329 Water St....Seaman-Sleeth Co., 41st St. and Willow..S. D. Sleeth, Westinghouse Air Brake Co....Washington Coal & Coke Co....Wm. Yagle & Co., Ltd., 23d St. & A. V. R. R.
Philadelphia—Stanley G. Flagg & Co., 19th and Pennsylvania Ave.... Girard Iron Works, 22d and Master....Wm. Hanson, 5404 Lancaster Ave....Arthur W. Howe....Dr. Edward Kirk, 535 N. 10th St

....Morris Wheeler & Co., 16th and Market Sts....J. W. Paxson & Co....Rogers, Brown & Warner, Bullitt Bldg....Isaac A. Sheppard & Co....Robert J. Taylor & Son....Josiah Thompson, J. Thompson & Co....Wilbraham Baker Blower Co....Walter Wood, R. D. Wood & Co., 400 Chestnut St.....David J. Matlack, 2247 Richmond St....Wm. Sellers & Co., Inc., 1600 Hamilton St....W. W. Stevens, 9th and Montgomery Ave....Asa W. Whitney, 1601 Callowhill St.

Quakertown—Francis Cavanaugh, Quakertown Stove Works.

Renova—W. H. Nicholas, P. R. R., Foreman of Foundry.

Sharpsville—Thos. D. West, Vice-Pres. & Mgr. Thos. D. West Foundry Company.

Tacony—Francis Schumann, Tacony Iron & Metal Co.

Weatherly—Jos. Koons, with L. V. R. R. Co.

Wilkes-Barre—E. H. Jones, 143 S. Franklin St.

RHODE ISLAND.

Providence—Alonzo D. Amsden, Phoenix Foundry....A. Carpenter & Sons, 272 W. Exchange....Theo. H. Colvin, Theo. H. Colvin Foundry Co....Alfred J. Miller, Vice-Pres. Whitehead Bros.' Co.

TENNESSEE.

Chattanooga—Henry Clay Evans, Mgr. Chattanooga Car & Foundry Co.

TEXAS.

Dallas—Mosher Mfg. Co.

VERMONT.

Montpelier—Lane Mfg. Co.

WASHINGTON.

Seattle—Geo. James, Mgr. Variety Iron Works.

Tacoma—Olympic Iron Works.

WISCONSIN.

Milwaukee—Northwestern Malleable Iron Co.

CANADA.

Londonderry—Chas. L. Jobb, Londonderry Iron Co.

Montreal, P. Q.—Warden, King & Son.

LIST OF NEW MEMBERS SINCE PUBLICATION OF LAST REPORT.

Sept. 14, 1896—Anniston Pipe & Foundry Co............Anniston, Ala.
Sept. 10, 1896—The Blymyer Iron Works Co..........Cincinnati, Ohio.
Sept. 19, 1896—Leland & Faulconer Mfg. Co............Detroit, Mich.
Sept. 21, 1896—McLagon Foundry Co...............New Haven, Conn.
Sept. 24, 1896—North & Judd Mfg. Co.............New Britain, Conn.
Sept. 22, 1896—Pittsburg Malleable Iron Co............Pittsburg, Pa.
Sept. 19, 1896—Washington Coal & Coke Co............Pittsburg, Pa.
Oct. 1, 1896—The Cleveland Facing Mill Co.........Cleveland, Ohio.

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